

# Lab: Electrolysis

## Introduction

When an electric current passes through an aqueous solution of a salt, chemical reactions take place at the electrodes. When these electrolytic reactions involve the decomposition of the electrolyte, the process is called electrolysis. In some cases, depending on:

(1) the position in the electrochemical series,

(2) the concentration and

(3) the nature of the electrolyte,

water itself could affect the outcome of the electrolysis because water does ionize to a small extent into hydronium and hydroxide ions.

In this experiment, you will electrolyze a concentrated solution of sodium sulfate. The course of the reaction is followed by means of an acid-base indicator, and the products identified. You will also electrolyze an aqueous solution of copper (II) chloride.

## Objectives

- To electrolyze an aqueous solution of sodium sulfate and copper (II) chloride.
- To identify the products of electrolysis.

## Apparatus and Materials

1 dm<sup>3</sup> beaker

2 test tubes (150 \* 15 mm)

2 test tubes stoppers

10 cm<sup>3</sup> graduated cylinder

DC power source

wood splints

marking pencil or rubber band

dilute sodium hydroxide

2 utility clamps

ring stand

2 connecting copper cables

gas burner

Sodium sulfate, Na<sub>2</sub>SO<sub>4</sub>, 0.10 mol dm<sup>-3</sup>

bromthymol blue indicator

Copper(II) chloride, 0.10 mol dm<sup>-3</sup>

## Safety:



Beware of electrical shock from electricity and water.

Copper compounds are poisonous and should not be spilled or flushed down the drain.

## Prelab Assignment

After reading through the procedure, design a suitable data table to record your results.

## Procedure

1. In a 100-250 cm<sup>3</sup> beaker, mix 100 cm<sup>3</sup> of water and about 3 g of sodium sulfate. (The concentration is not critical for the experiment.) Stir to make a clear solution.

2. Slowly add bromthymol blue indicator until a deep green color results. Use dilute sodium hydroxide or sulfuric acid to adjust the color. It is essential for the solution to be green prior to electrolysis.

3. Fill two test tubes with the green sodium sulfate solution. Stopper the test tubes, making sure that they are still completely filled with liquid. Invert these test tubes and place them into the beaker under the green solution. Clamp the test tubes in place and remove the stoppers.

4. Slide the graphite electrodes under the test tubes so that they are just BENEATH the mouth of the test tubes.

5. Connect the electrodes to the terminals of the DC power source (or a 6 v accumulator) as shown in the diagram below.

- Adjust the voltage to 5.0 V and start the electrolysis until the liquid level in one of the test tubes falls to about 2 cm above the mouth of the test tube. Record any color observations as the reaction progresses. Turn off the power, and mark the liquid levels in both test tubes with a marking pencil or rubber band.
- Slowly raise the test tubes, still keeping them vertical. As soon as all the liquid has run out of the test tubes, stopper them.
- Identify the gases in each test tube, using a glowing splint for the gas collected at the anode and a burning splint for the gas collected at the cathode of the gas collected in each test tube.
- Repeat the experiment using copper (II) chloride solution, (NOTE: **do not use bromothymol blue**), and identify any gas collected using moist indicator paper and any solid product observed at the other electrode.

### Data Analysis

For the electrolysis of  $\text{Na}_2\text{SO}_4(\text{aq})$

- Explain the colors observed in the electrolysis of  $\text{Na}_2\text{SO}_4(\text{aq})$  at the electrodes.
- What types of compounds were produced?
- What are the identities of the gases produced at the electrodes?
- Write balanced equations for the half-cells and the overall equations of the cell.
- On the basis of the half-cell reactions, explain why the final color of the solution is still green.
- Calculate the ratio of the volumes of the gases produced. Is it in agreement with the theory?
- Explain why no metal is plated out in this experiment.

For the electrolysis of  $\text{CuCl}_2(\text{aq})$

- Write the half-cell and the overall reaction occurring.
- What mass change, if any, would you observe in any of the electrodes during the electrolysis of  $\text{CuCl}_2(\text{aq})$ .
- What changes in colour of the solution are observed during the electrolysis of  $\text{CuCl}_2(\text{aq})$ .

### Extension

- List the factors that affect the amount of product formed during electrolysis.
- Predict the products in the electrolysis of aqueous solutions of:
  - copper (II) sulphate
  - silver nitrate
  - sodium bromide
- Determine the mass of copper that will be deposited if a current of 2.55 A is passed for 20 minutes and 10 seconds through a solution of copper (II) chloride.

### Conclusion

Provide a concluding statement as to the purpose of this lab.

### Diagram